

# Contrails

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# Outline

- Introduction – What are contrails?
- Making a cloud (how contrails form)
- Why do we study contrails?
- S'COOL and contrails
- Contrail cousins

# Introduction

- Contrails are **CLOUDS** that form in the wake of aircraft.
- Contrail is a shortened name for condensation trails.
- Also known as vapor trails, jet trails, “chemtrails”



# Contrails have been around for a long time!



- They were first described in the scientific literature in 1919.
- During WWII, contrails sometimes littered the skies during aerial combat.

# Making A Cloud

Clouds form when water vapor in the air condenses into visible water droplets or ice crystals.

Condensation can occur in two ways:

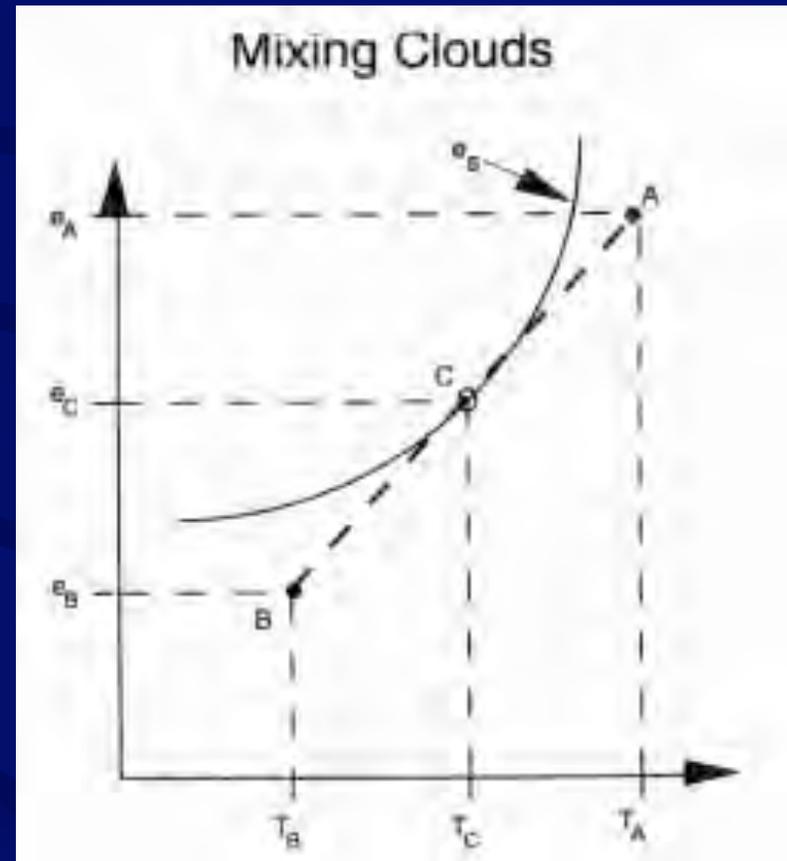
1. Increase the water content in the air.
2. Cool the air to reach the dew point.

## Making A Cloud (Part 2)

Nearly all contrails form by the **mixing** of the colder, drier atmosphere with the warmer, wetter jet exhaust (*mixing cloud*).

# Mixing clouds

- Mixing clouds form because the ability of air to 'hold' water vapor increases rapidly with temperature.
- Like contrails, the cloud that forms on your breath during a cold day is a mixing cloud.



# Nearly all contrails are mixing clouds



Most contrails that you see in the sky form at high altitudes (above 26,000 ft) and at very cold temperatures (less than  $-40^{\circ}\text{F}$ ).

# Why Do We Study Contrails?



Contrails cause detection and visibility problems for military aircraft.



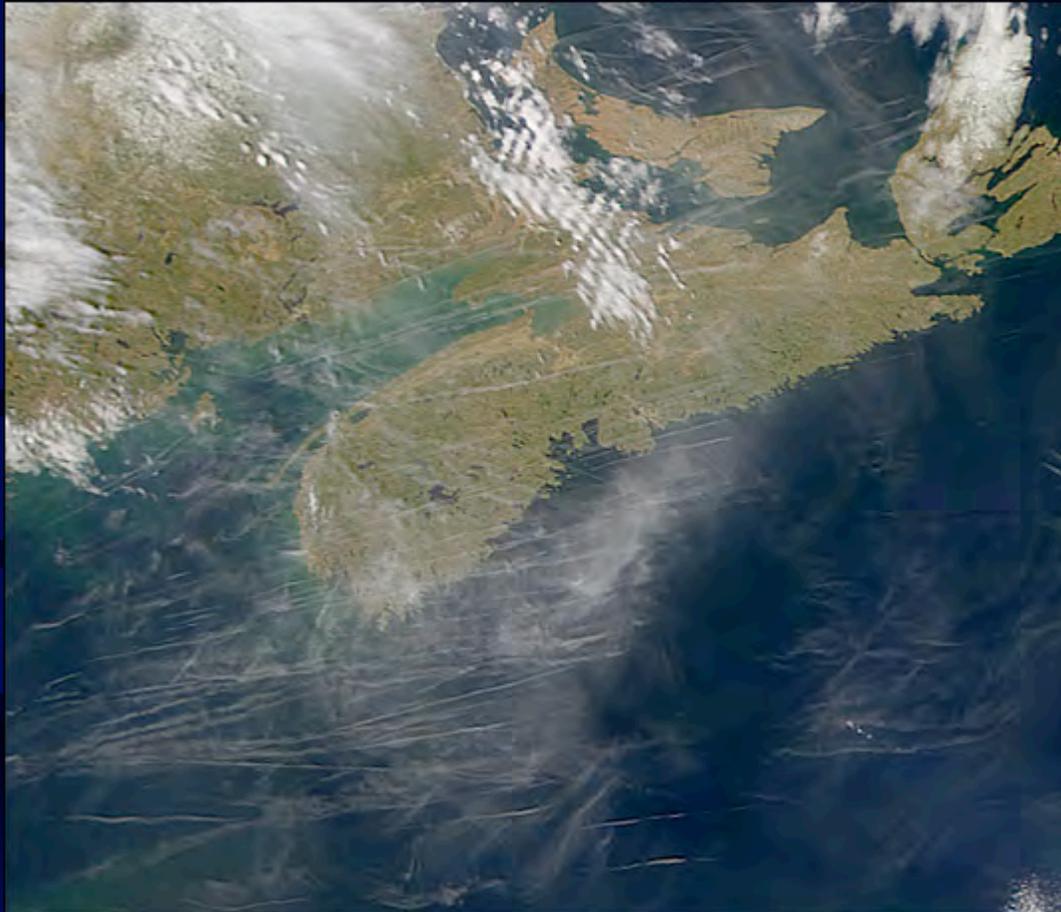
When the upper atmosphere is moist enough, the contrails continue to grow.



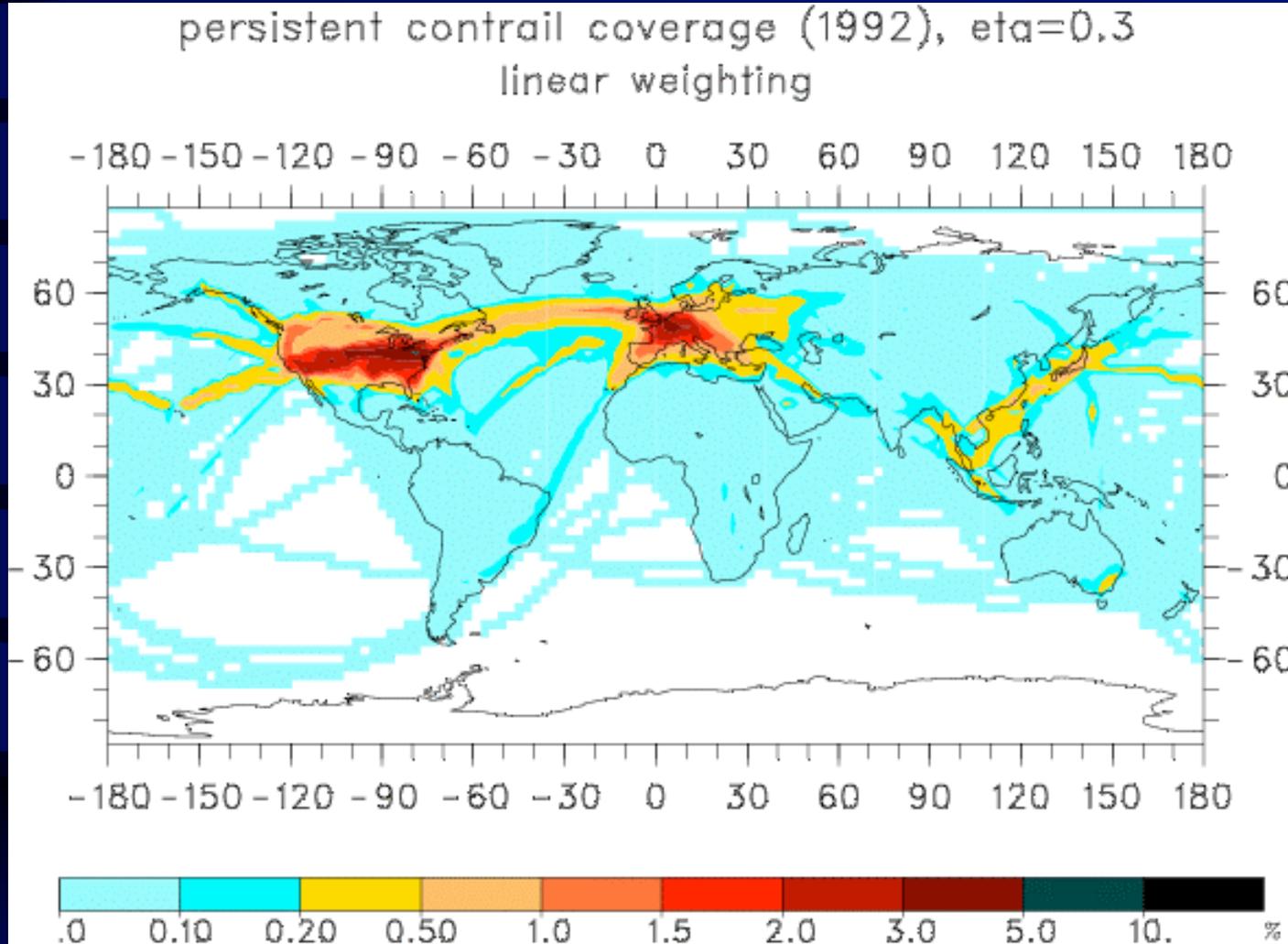
Under these conditions, the contrails become **persistent.**

Persistent  
contrails  
occasionally  
cover large  
areas.

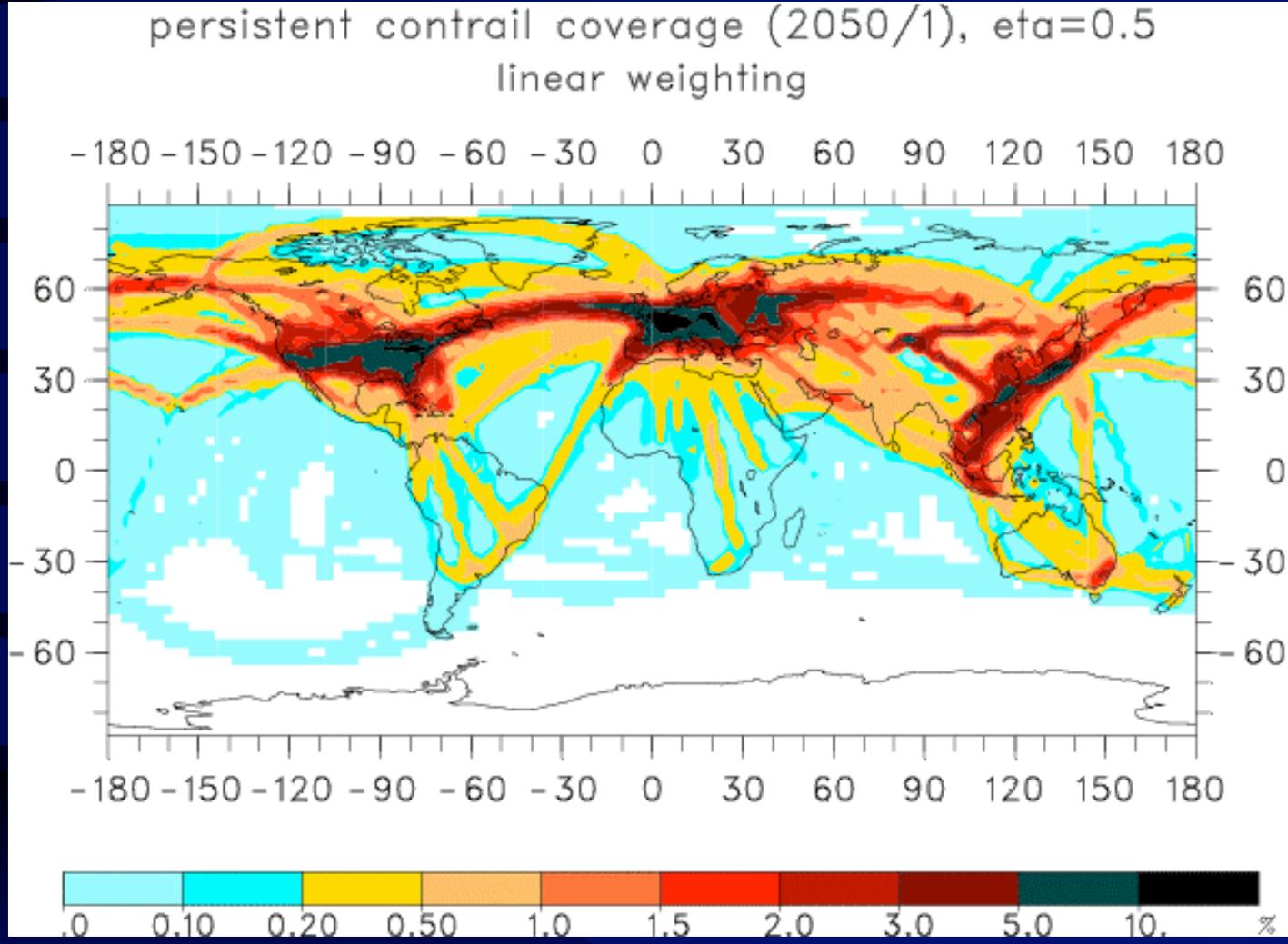
Like cirrus  
clouds,  
contrails  
likely  
contribute to  
global  
warming.



We currently  
estimate that  
contrails add  
an additional  
0.5 to 5  
percent  
warming to the  
greenhouse gas  
effect.



Air traffic and persistent contrail coverage will continue to increase.

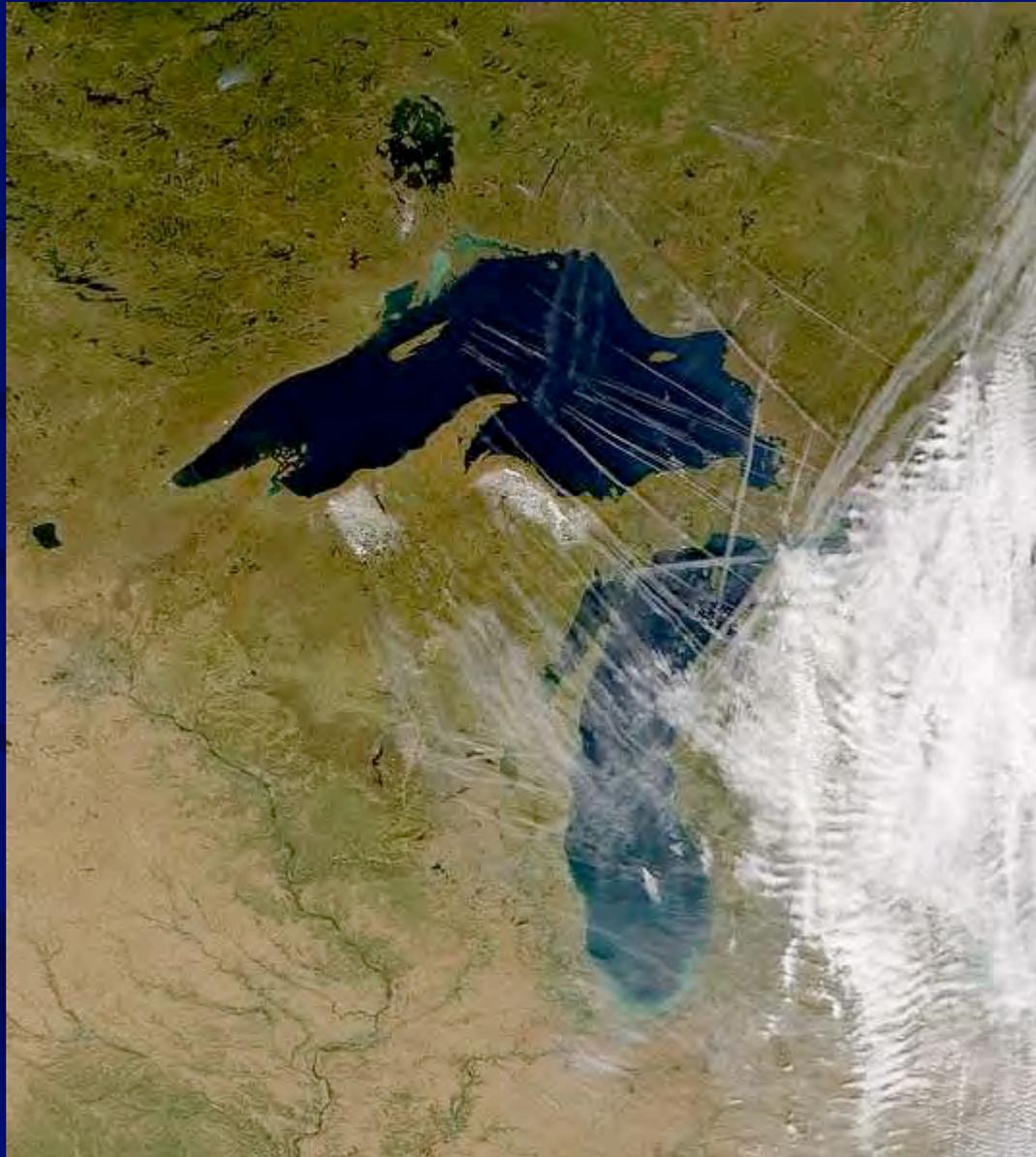


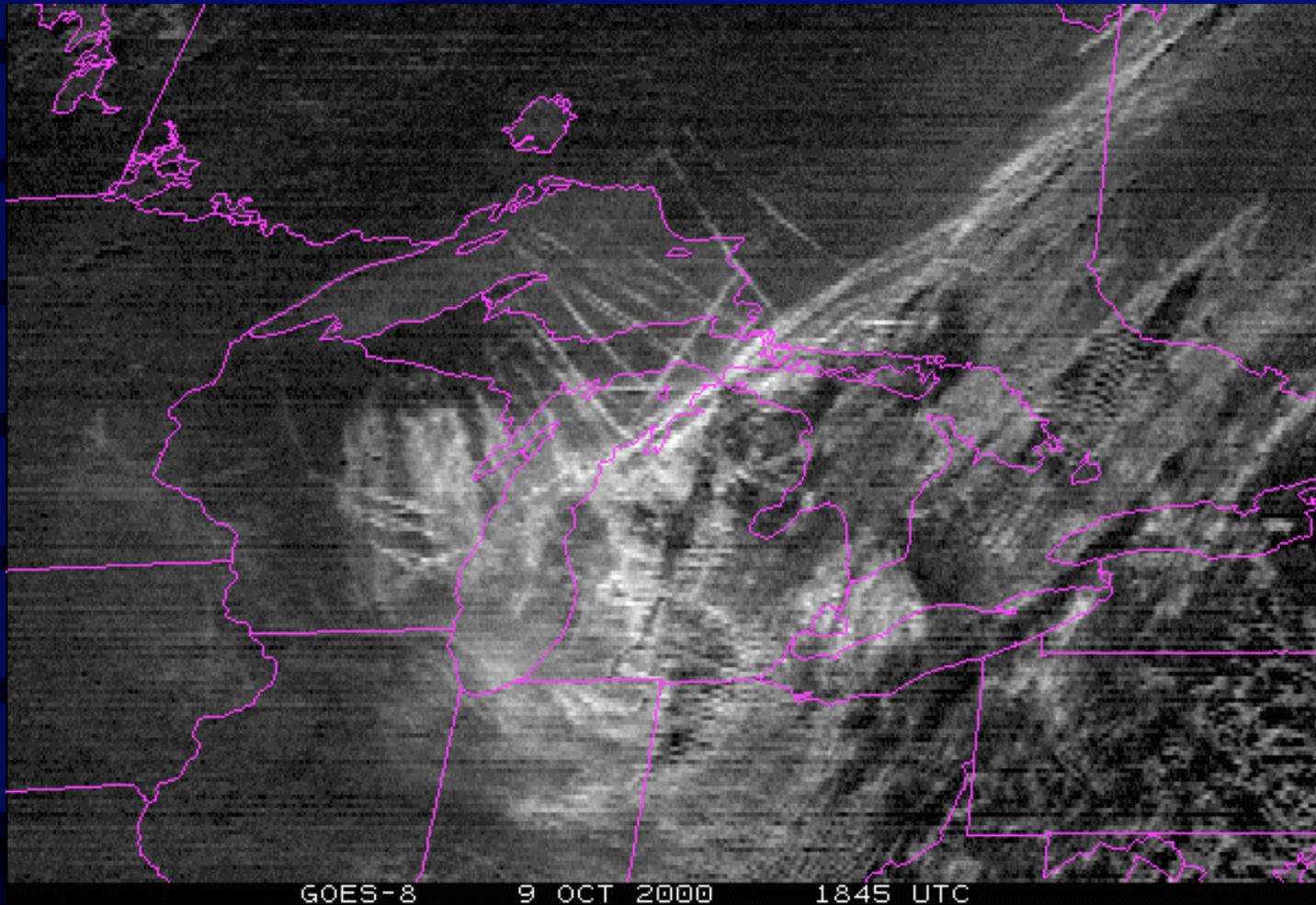
By 2050, the warming due to contrails may be 2.5 to 25 percent of the current greenhouse gas warming.

# S'COOL and Contrails

Our estimates  
of the  
climatic  
effects of  
persistent  
contrails are  
still  
uncertain.

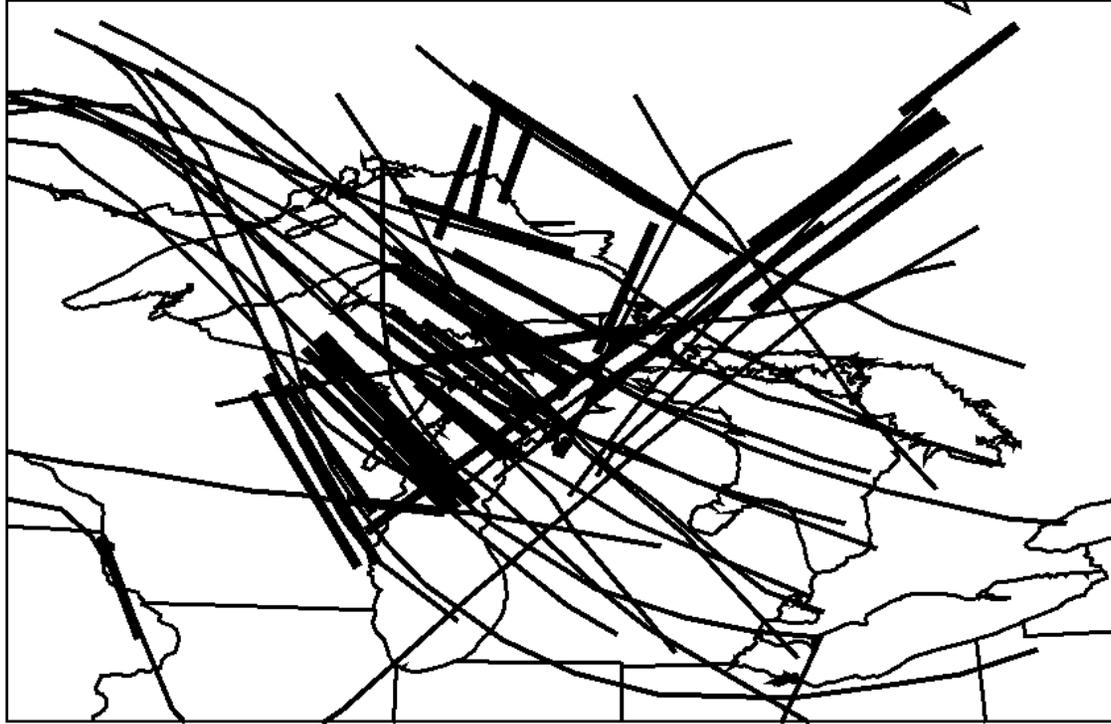
We still have  
trouble  
estimating  
contrail  
coverage.





Most contrails are still smaller than the resolution of most satellites.

17:45 UTC 9 October 2000



Using inventories of commercial aircraft flight data and satellite data, we are learning more about the growth and coverage of contrails under different atmospheric conditions. Surface observations from S'COOL would improve our studies.

# Contrail Cousins

# Unconventional Contrails (clouds, but not mixing clouds)



# Contrails (not!)



This B-52 is producing smoke!

Skywriting planes also produce smoke. Often the smoke is from a type of cooking oil!



# Inverse contrails (distrails)



Aircraft sometimes make holes in clouds!